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Subject: WPR22LA333, N687AM Collective Stick Examination Report

The collective stick came from a Bell 407, N687AM, that was involved in an accident on September 4, 2022, near Mount Baldy, California. The total part time was reported to be 6,942 hours. Representatives from the FAA, Air Methods, and Rolls-Royce were present for the examination of the helicopter's collective stick assembly that occurred at Bell Headquarters in Fort Worth, Texas on October 19, 2022.

The throttles of multiple Model 407 aircraft from the Bell Training Academy with varying flight hours were rotated in and out of the FLY detent to compare with the accident throttle. On all the 407 models there was an audible and physical click when the ball plunger nested into the detent groove, and also did not require much additional force to rotate the throttle out of the FLY detent towards IDLE. It was also observed that the Model 407s with more flight hours also had more perceived wear at the detent position.

The bottom of the collective stick was mounted in a vice and the throttle was manipulated by hand, and the friction force of the throttle was measured in accordance with Bell Technical Bulletin DMC-407-A-76-04-00-00A-280A-A, THROTTLE/FLY DETENT Friction Check. When the throttle was manipulated by hand from the ground idle position, the FLY detent could be felt when it was reached. When the throttle was rotated upwards from FLY to Max Ng, it could be felt going out of the detent. When the throttle was rolled down from the FLY position towards Idle, there was perceivably less tactile resistance as the ball plunger moved out of the detent. The frictional force was measured in four different throttle positions on the accident collective. Results are shown in Table 1. The torque to rotate the ball plunger out of the FLY detent towards IDLE measured 3 inch-pound. The torque to rotate the ball plunger out of the FLY detent towards MAX NG measured 4 inch-pound.

The torque to rotate the ball plunger from IDLE to the FLY detent and from MAX NG to the FLY detent both measured 3 inch-pounds.

The frictional force of another throttle with 1,037 flight hours was measured on a Model 407 (S/N-53371) at the Bell Training Academy to compare if the force to rotate the throttle was similar to the accident collective. The force was similar, and the results are shown in Table 2. Note that the Bell Training Academy 407 throttle's friction was measured while it was attached to the whole throttle system, while the accident 407 collective was not.

The ball plunger was removed from the accident helicopter's collective (figure 1) and the spring force was tested with a load frame. The spring met the design requirements of 4lbs \pm 25% initial force and 12 lbs \pm 25% final force that was specified by the manufacturer. Initial force is the force it takes to start compressing the spring. Final force is the force it takes the spring to compress the distance specified by the manufacturer.

The detent bracket was removed from the collective and then analyzed with a digital optical microscope. The groove angle measured 90°. The bottom radius measured 0.020 inch. Both radii on either side of the detent groove measured 0.040 inch.

Superficial wear was observed where the ball plunger slid against the detent bracket, measuring less than 0.001 inch (figure 3). A wear indentation was noted on the radius of the detent groove, between FLY and IDLE. The indentation measured 0.055 inch in length and 0.035 inch in width. Its depth was 0.009 inch measured from the flat of the detent bracket to the bottom of the indentation.

Throttle Friction Force Test from Accident 407		
Positions	Force (pounds)	Torque (inch-pounds)
IDLE to FLY	4	3
FLY to IDLE	4	3
MAX NG to FLY	4	3
FLY to MAX NG	5	4

Table 1: Friction force and torque results from accident 407 throttle.

Throttle Friction Force from Bell Training Academy 407	
Positions	Force (pounds)
IDLE to FLY	4
FLY to IDLE	5
MAX NG to FLY	4
FLY to MAX NG	5

Table 2: Friction force results from Bell Training Academy 407 throttle.

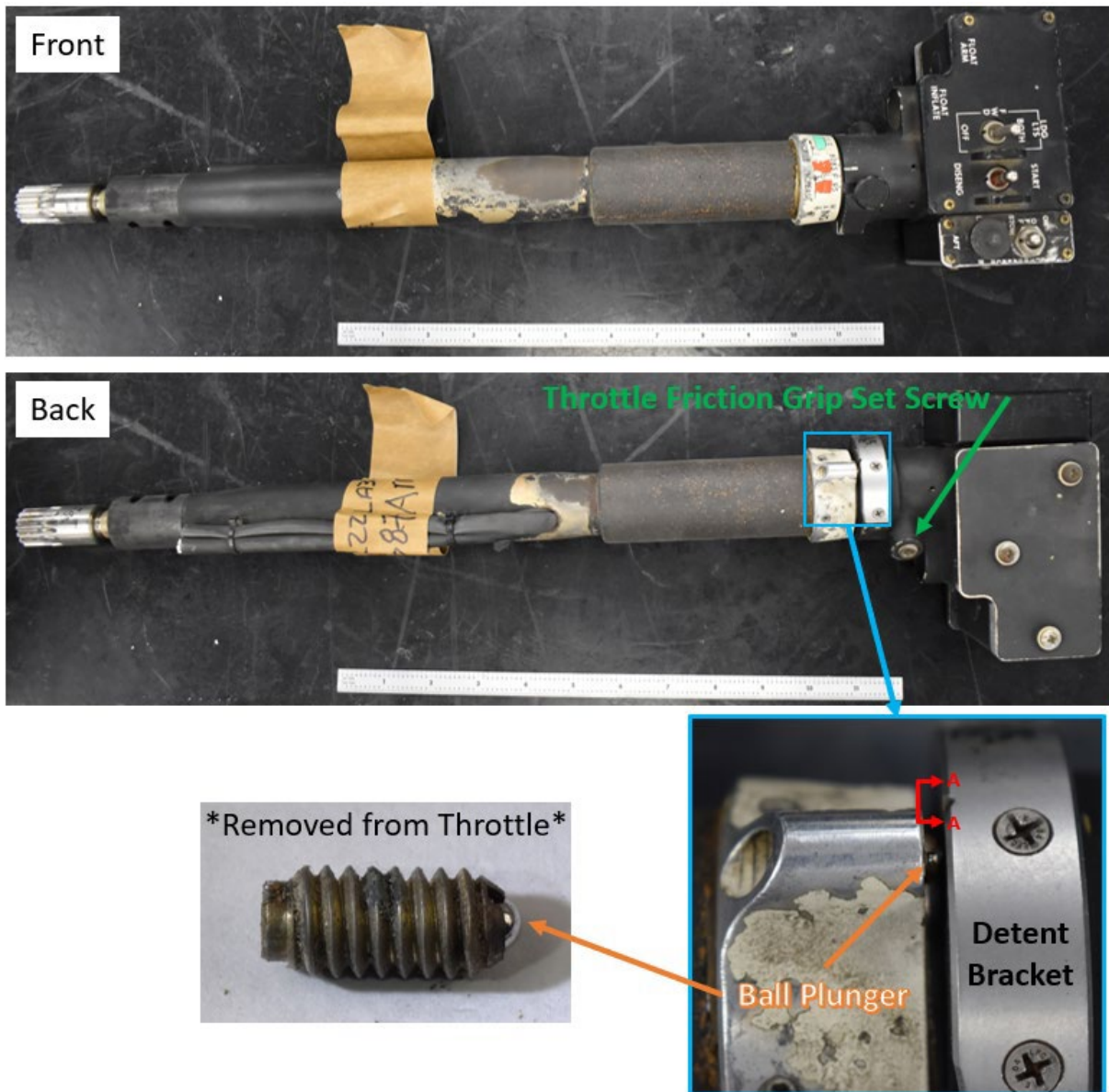


Figure 1 - Collective as Received and Ball Plunger (Bell Photograph)

The detent bracket was removed from the collective and then analyzed with a digital optical microscope. The groove angle measured 90° , which met the engineering drawing requirement. The bottom radius measured 0.020 inch, which met the engineering drawing requirement. Both radii on either side of the detent groove measured 0.040 inch, which met the engineering drawing requirement.

Superficial wear was observed where the ball plunger slid against the detent bracket, measuring less than 0.001 inch. A wear indentation was noted on the radius

of the detent groove, between FLY and IDLE. The indentation measured 0.055 inch in length and 0.035 inch in width. Its depth was 0.009 inch measured from the flat of the detent bracket to the bottom of the indentation. See figures 2 and 3.

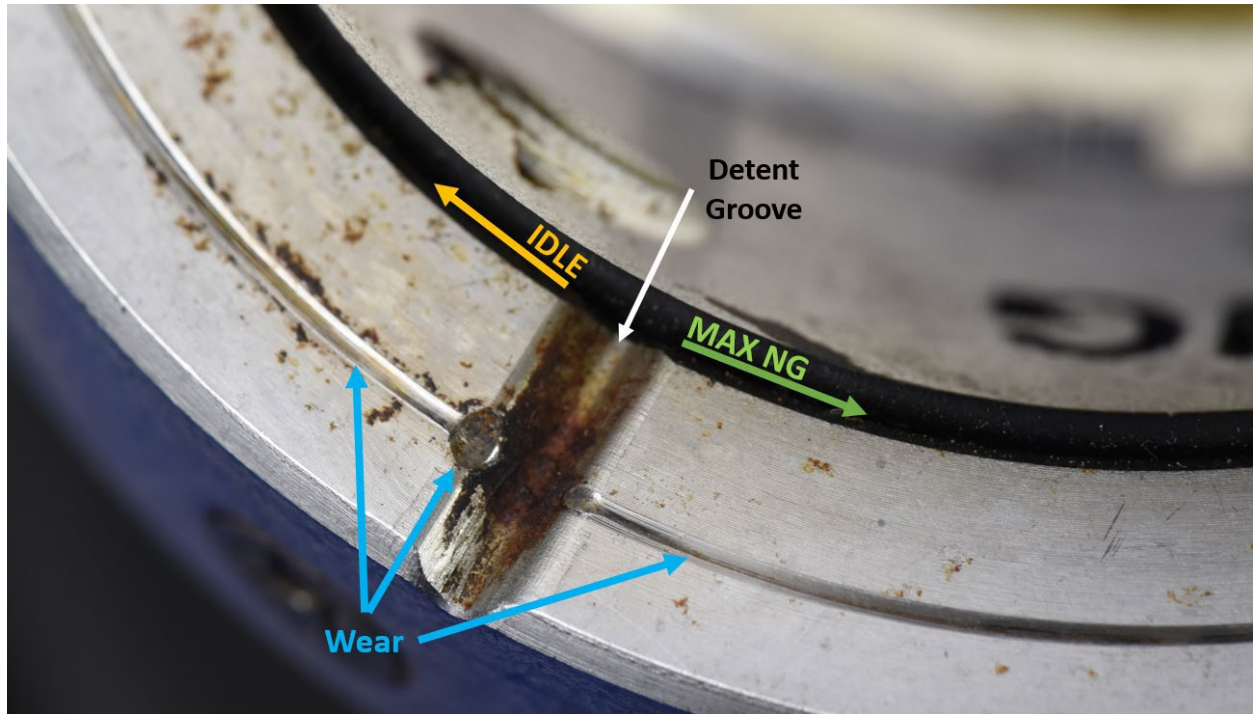


Figure 2 - Collective Detent Wear (Bell Photograph)

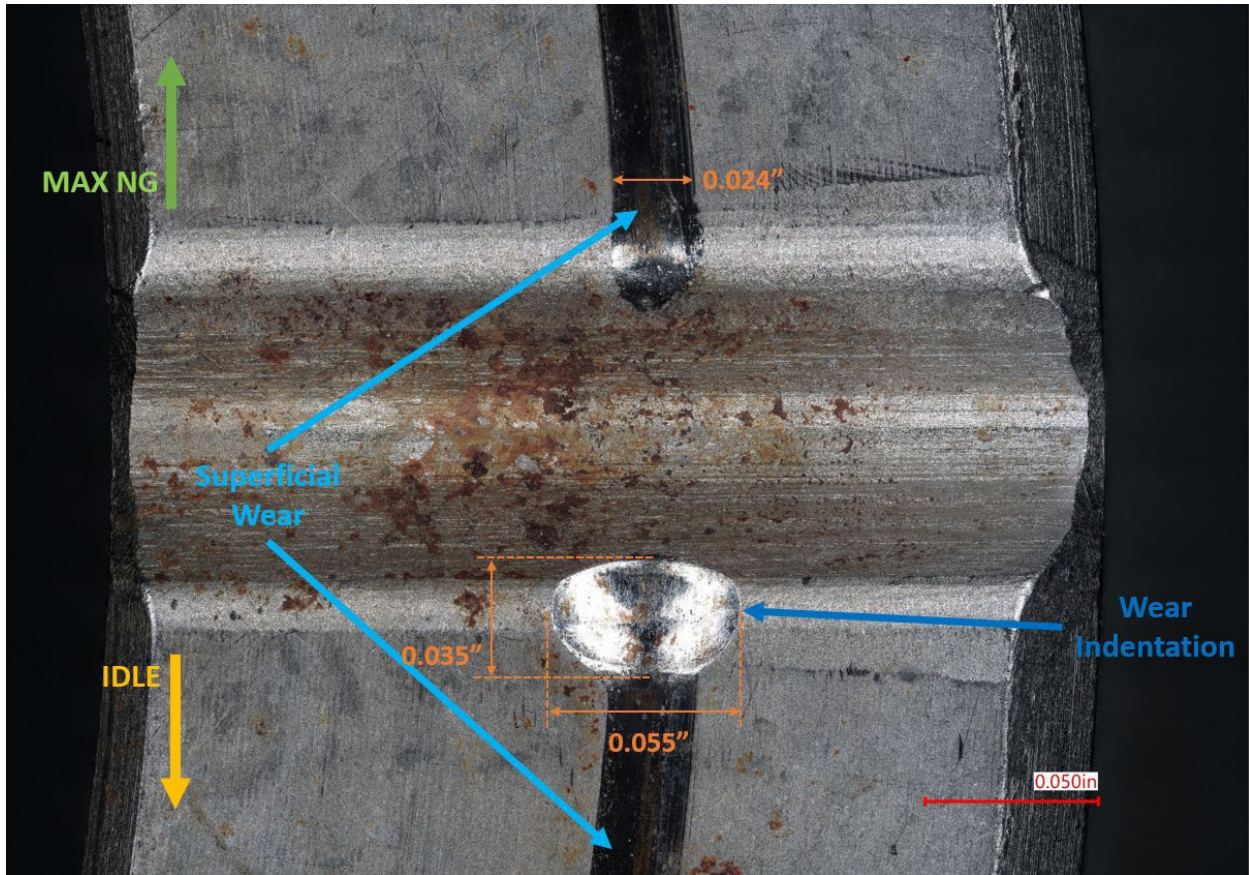


Figure 3 -Collective Detent Wear with Measurements (Bell Photograph)